

(19) World Intellectual Property
Organization
International Bureau



(43) International Publication Date
15 July 2004 (15.07.2004)

PCT

(10) International Publication Number
WO 2004/059806 A3

(51) International Patent Classification⁷: **H01S 3/098**

(21) International Application Number:
PCT/US2003/041091

(22) International Filing Date:
22 December 2003 (22.12.2003)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
60/435,577 20 December 2002 (20.12.2002) US

(71) Applicants (for all designated States except US): **AL-NAIRE LABORATORIES CORPORATION** [JP/JP]; 6-3-14, Kawaguchi, Kawaguchi City, Saitama-ken, Japan 332-0015 (JP). **NATIONAL INSTITUTE OF ADVANCED INDUSTRIAL SCIENCE AND TECHNOLOGY** [JP/JP]; 1-1-1, Umezono, Tsukuba, Ibaraki 305-8568 (JP).

(72) Inventors; and

(75) Inventors/Applicants (for US only): **JABLONSKI, Mark, Kenneth** [US/JP]; 18-18-208, Toku Maru,

Itabashi-ku, Tokyo 175-0083 (JP). **SET, Sze, Yun** [MY/JP]; 1-5-5-301, Kamiya, Kita-ku, Tokyo 115-0043 (MY). **TANAKA, Yuichi** [JP/JP]; 3-20-18, Meehara, Koganei City, Tokyo (JP).

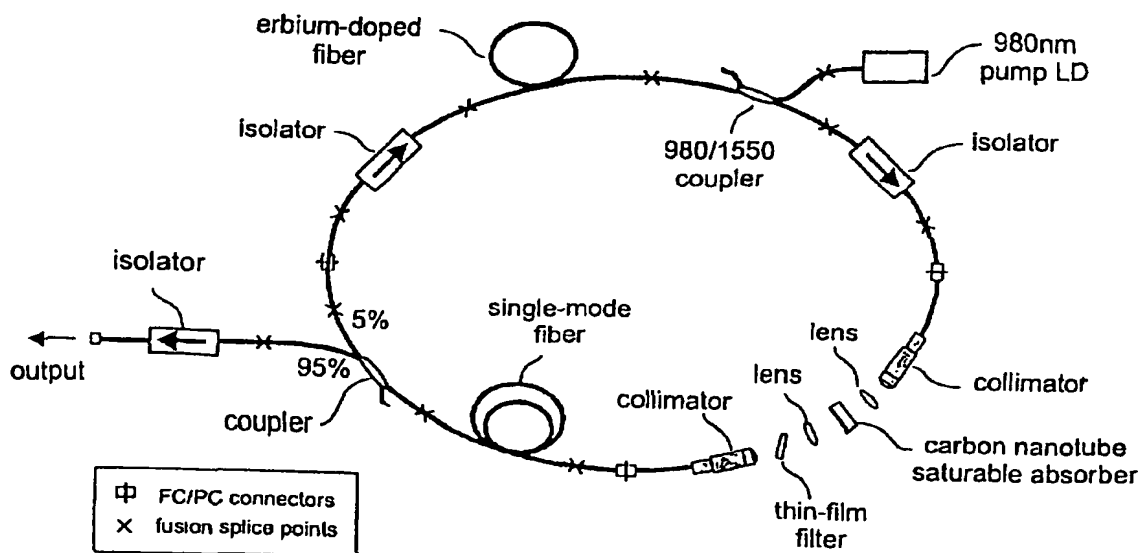
(74) Agents: **SULLIVAN, Sally, A.** et al.; Greenlee, Winner & Sullivan, P.C., 5370 Manhattan Circle, Suite 201, Boulder, CO 80303 (US).

(81) Designated States (*national*): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(84) Designated States (*regional*): ARIPO patent (BW, GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

[Continued on next page]

(54) Title: OPTICAL PULSE LASERS



(57) **Abstract:** The present invention provides pulsed lasers which employ carbon nanotubes, particularly layers of carbon nanotubes, as saturable absorbers, mode lockers or for Q-switching elements. The present invention also provides methods and materials for mode-locking and Q-switching of lasers in which carbon nanotubes are employed as non-linear optical materials and/or saturable absorbers which facilitate mode-locking and/or Q-switching. The invention further provides mode locker and Q-switching elements or devices which comprise one or more layers containing carbon nanotubes which layer or layers function for mode locking and/or Q-switching.

WO 2004/059806 A3



Published:

- with international search report
- before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(88) Date of publication of the international search report:
23 September 2004

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US03/41091

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) : H01S 3/098

US CL : 372/18, 6

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 372/18, 6, 99; 423/447.1; 96/154

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
NONE

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
NONE

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5,689,519 A (FERMANN et al.) 18 November 1997 (18.11.1997), the entire document	1-47
Y	US 2002/0192142 A1 (TILLOTSON et al.) 19 December 2002 (19.12.2002), the entire document	1-47

☐ Further documents are listed in the continuation of Box C.

☐ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"B" earlier application or patent published on or after the international filing date

"L" document \ may throw doubts on priority claim(s) or which is cited to establish d lication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T"

later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X"

document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y"

document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&"

document member of the same patent family

Date of the actual completion of the international search

23 April 2004 (23.04.2004)

Date of mailing of the international search report

06 AUG 2004

Name and mailing address of the ISA/US

Mail Stop PCT, Attn: ISA/US
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

Facsimile No. (703) 305-3230

Authorized officer

Nguyen (Michael) Dung

Telephone No. (571) 272-1949